UNITED STATES PATENT AND TRADEMARK OFFICE

UNITED STATES DEPARTMENT OF COMMERCE
United States Patent and Trademark Office
Address: COMMISSIONER FOR PATENTS
P.O. Box 1450
Alexandria, Virginia 22313-1450
www.uspto.gov

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
10/663,300	09/15/2003	Vi Vuong	509982005600	2605

20872 7590 04/11/2007

MORRISON & FOERSTER LLP
425 MARKET STREET
SAN FRANCISCO, CA 94105-2482

EXAMINER	
TZATHAS, ANASTASIOS	
ART UNIT	**PAPER NUMBER**
2809	

SHORTENED STATUTORY PERIOD OF RESPONSE	MAIL DATE	DELIVERY MODE
3 MONTHS	04/11/2007	PAPER

Please find below and/or attached an Office communication concerning this application or proceeding.

If NO period for reply is specified above, the maximum statutory period will apply and will expire 6 MONTHS from the mailing date of this communication.

Office Action Summary	Application No. 10/663,300	Applicant(s) VUONG ET AL.	
	Examiner Anastasios Tzathas	Art Unit 2809	

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) OR THIRTY (30) DAYS, WHICHEVER IS LONGER, FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

1)☐ Responsive to communication(s) filed on _____.

2a)☐ This action is **FINAL**. 2b)☒ This action is non-final.

3)☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

4)☒ Claim(s) *1-35* is/are pending in the application.

4a) Of the above claim(s) _____ is/are withdrawn from consideration.

5)☐ Claim(s) _____ is/are allowed.

6)☒ Claim(s) *1 thru 9, 11 thru 18 and 20 thru 35* is/are rejected.

7)☒ Claim(s) *10 and 19* is/are objected to.

8)☐ Claim(s) _____ are subject to restriction and/or election requirement.

Application Papers

9)☐ The specification is objected to by the Examiner.

10)☐ The drawing(s) filed on _____ is/are: a)☐ accepted or b)☐ objected to by the Examiner.

Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).

Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).

11)☐ The oath or declaration is objected to by the Examiner. Note the attached Office Action or form PTO-152.

Priority under 35 U.S.C. § 119

12)☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).

a)☐ All b)☐ Some * c)☐ None of:

1.☐ Certified copies of the priority documents have been received.

2.☐ Certified copies of the priority documents have been received in Application No. _____.

3.☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

* See the attached detailed Office action for a list of the certified copies not received.

Attachment(s)

1) ☒ Notice of References Cited (PTO-892)

2) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948)

3) ☒ Information Disclosure Statement(s) (PTO/SB/08) Paper No(s)/Mail Date *1/10/07*.

4) ☐ Interview Summary (PTO-413) Paper No(s)/Mail Date. _____ .

5) ☐ Notice of Informal Patent Application

6) ☐ Other: _____.

DETAILED ACTION

This Office Action is in response to the Application filed on 09/15/2003.

Specifically, this Office Action is in response to the following documents:

1. Specification received on: 09/15/2003.
2. Drawings received on: 09/15/2003.
3. Claims received on: 09/15/2003.

Claim Objections

Claims 10 and **19** are objected to under 37 CFR 1.75(c), as being of improper dependent form for failing to further limit the subject matter of a previous claim.

Applicant is required to cancel the claim, or amend the claim to place the claim in proper dependent form, or rewrite the claim in independent form.

Claim Rejections - 35 USC § 101

35 U.S.C. 101 reads as follows:

> Whoever invents or discovers any new and useful process, machine, manufacture, or composition of matter, or any new and useful improvement thereof, may obtain a patent therefor, subject to the conditions and requirements of this title.

Claims 20 through **27** are rejected under 35 U.S.C. 101 because the claimed invention in the said claims fail to include transformation from one physical state to another. Merely going thru the steps as claimed would not appear to be sufficient to constitute a tangible result. As such, the subject matter of the claims is not patent eligible. Also, the computer code does not belong to any of the four statutory catalogs of 35 U.S.C. 101.

Claim Rejections - 35 USC § 102

The following is a quotation of the appropriate paragraph of 35 U.S.C. 102 that forms the basis for the rejections under this section made in this Office action:

> A person shall be entitled to a patent unless –
>
> (e) the invention was described in (1) an application for patent, published under section 122(b), by another filed in the United States before the invention by the applicant for patent or (2) a patent granted on an application for patent by another filed in the United States before the invention by the applicant for patent, except that an international application filed under the treaty defined in section 351(a) shall have the effects for purposes of this subsection of an application filed in the United States only if the international application designated the United States and was published under Article 21(2) of such treaty in the English language.

Claims 1, 4, 5, 6, 7, 8, 9, 11, 12, 13, 14, 16, 17, 18, 28, 30, 31, 32, 33, 34 and **35** are rejected under U.S.C. 102 (e) as being unpatentable over Balasubramanian et al. (US 2004/0017575, FILING-DATE: 03/25/2003).

Claim 1: A method of selecting a hypothetical profile to model the profile of a structure formed on a semiconductor wafer to use in determining the profile of the structure using optical metrology,

the method comprising:

(a): obtaining sample diffraction signals from measured diffraction signals of structures formed on the wafer, wherein the sample diffraction signals are a representative sampling of the measured diffraction signals;

(b): defining a hypothetical profile to model profiles of the structures formed on the wafer;

and

(c): evaluating the hypothetical profile using a sample diffraction signal from the obtained sample diffraction signals.

In regards to **Claim 1**, Balasubramanian et al. disclose:

A profile model for use in optical metrology and a modeling process (method): Abstract; lines 1-8.

(a): an optical metrology system is used to measure diffraction signals off structures patterned on a wafer: [0044]; lines 1- 3 and Figure1. A set of diffraction signals are selected from the input measured diffraction signals: [0067]; lines 1- 3, lines 6- 10 and Figure 3.

(b): a hypothetical profile used to approximate

the actual profile: [0055]; lines 1- 3 and Figures 9A, 9B and 9C.

(c): a hypothetical profile from library 54 is evaluated against measured diffraction beam data 57: [0067]; lines 1-3 and lines 16-19.

Claim 4: The method of claim 1, wherein defining a hypothetical profile comprises: characterizing the hypothetical profile using two or more parameters.

In regards to **Claim 4**, Balasubramanian et al. disclose:

The method and the impact of the number of parameters used in the hypothetical profile: [0054]; lines 1-23 and [0055]; lines 1-5.

Claim 5: The method of claim 1, wherein evaluating the hypothetical profile comprises:

(a): accessing a sample diffraction signal from the obtained sample diffraction signals;

(b): determining a simulated diffraction signal corresponding to the sample diffraction signal;

(c): determining a goodness of fit between the sample diffraction signal and the simulated diffraction signal; and

(d): modifying the hypothetical profile when the goodness of fit does not meet a goodness of fit criterion.

In regards to **Claim 5,** Balasubramanian et al. disclose:

(a): obtain measured diffraction signals off several sites in the wafer: [0067]; lines 1-3 and [0067]; lines 16-19.

(b): for each measured signal perform the procedure to determine the corresponding optimized simulated signal: [0098]; lines 1-4 and Figure 7.

(c): the Goodness Of Fit (GOF) is used as the termination criterion in the process of matching the measured signal to a simulated signal: [0069]; lines 1-5 and step 460 in Figure 3.

(d): continuing with step 470 in Figure 3, if the data gathering criterion is not met then the profile model (hypothetical profile) is adjusted accordingly: [0070]; lines 1-6.

Claim 6: The method of claim 5, wherein steps (a), (b), (c), and (d) are repeated for each of the sample diffraction signals.

In regards to **Claim 6,** Balasubramanian et al. disclose:

Perform a procedure to determine the optimized simulated signal for each measured signal: [0098]; lines 1-18 and Figures 6A and 7.

The said disclosed procedure would inherently use steps (a), (b), (c) and

(d) for each of the selected diffraction signals.

Claim 7: The method of claim 5, wherein the sample diffraction signal accessed in step (a) is closest to a center of a range of sample diffraction signals.

In regards to **Claim 7,** Balasubramanian et al. disclose:

Representatives of each cluster or group of highly correlated measured diffraction signals are selected for use in the model and parameter selection processing: [0067]; lines 16-19.

(Note: the data mining/reduction process (clustering) which is claimed by the applicants in Claim 2 and shown by Balasubramanian et al. (refer to corresponding prosecution in element **(b)** of Claim 2) produces clusters or groups/ranges of correlated measured diffraction signals. The center of each cluster (group or range) and the data points (measurements) closest to the center are inherently the best candidates (highly correlated) for modeling and parameter selection.

In clustering methods for data mining/reduction, the center of the cluster which is called the centroid is considered *as the center of gravity* for the respective cluster).

The best candidates (highly correlated) will inherently fall at center of the range.

Claim 8: The method of claim 1, wherein evaluating the hypothetical profile comprises:

(a): obtaining a sample diffraction signal;

(b): determining a simulated diffraction signal corresponding to the sample diffraction

(c): determining a global minimum error; and

(d): modifying the hypothetical profile when the global minimum error exceeds a global minimum error criterion.

In regards to **Claim 8,** Balasubramanian et al. disclose:

(a): obtaining measured diffraction signals from several sites off the wafer and using a template to make a selection from the said diffraction signals: [0096]; lines 7-13.

(b): for each measured signal perform the procedure to determine the corresponding optimized simulated signal: [0098]; lines 1-4 and Figure 7.

(c): various optimization engines are used to arrive at a global minimum error (difference) between simulated signal and the measured signal: [0095]; lines 1-15 and Figure 7.

(d): If the termination criterion (error) is not met then the profile model (hypothetical profile) is adjusted as part of the process to minimize the error: [0098]; lines 11-18.

Claim 9: The method of claim 8, wherein steps (a), (b), (c), and (d) are repeated for each of the sample diffraction signals.

In regards to **Claim 9,** Balasubramanian et al. disclose:

a procedure is performed to determine the optimized simulated signal for each measured signal: Perform a procedure to determine the optimized simulated signal for each measured signal: [0098]; lines 1-18 and Figures 6A and 7. The said disclosed procedure would inherently use steps (a), (b), (c) and (d) for each of the selected diffraction signals.

Claim 11: The method of claim 1, further comprising:

(a): determining sensitivity for one or more parameters that characterize the hypothetical profile; and

(b): modifying the hypothetical profile when the determined sensitivity is not acceptable or does not meet a sensitivity criterion.

In regards to **Claim 11,** Balasubramanian et al. disclose:

(a): sensitivity of a profile parameter: [0052]; lines 1-4.

(b): a sensitivity cutoff may be adjusted in the process of modifying the model: [0060]; lines 1-8 and Figure 2.

Claim 12: The method of claim 1, further comprising:

(a): generating one or more mini-libraries based on the obtained sample diffraction signals, wherein a mini-library is smaller in size than a full library to be generated;

(b): processing test diffraction signals using the one or more mini-libraries; and

(c): estimating an averaged error and precision based on results of processing the test diffraction signals.

In regards to **Claim 12,** Balasubramanian et al. disclose:

(a): a library of calculated (simulated) diffraction beam data (signals) representing varying combinations of critical dimensions of target structure and resolution of the critical dimensions. (The said library would inherently contain a broad range of data necessary to build a full library): [0044]; lines 10-15 and Figure 1. Profile models (hypothetical profiles) of varying complexities which are used to build the full library are disclosed in [0054]; lines 1-23. Sub-templates, which would inherently generate subsets

(mini-libraries) from the full library are disclosed in [0110]; lines 1-18.

(b): process simulated (test) diffraction signals from one or more sub-templates (mini-libraries): [0109]; lines 2-4 and [0110]; lines 11-18.

(c): the library optimization process includes determining

two parameters an average error and a precision based on measured diffraction signals and simulated diffraction signals and their corresponding profiles respectively:

Average error: the average value of one parameter or set of parameters are used as a target (average error): [0085]; lines 1-14 and [0086]; lines 1-3.

Precision: (Precision is the second data criterion selected by the Applicants. Applicants' disclosure define an example of a precision criterion as the 3-times the standard deviation of a set of measured diffraction signals. (Note: the said precision criterion is commonly used in statistical quality control)).

Balasubramanian et al. also disclose a second data gathering criterion precision: the 3-sigma (standard deviation) of measured diffraction signals for the same site in the wafer: [0065]; lines 9-12.

Claim 13: The method of claim 12, further comprising:

(a): determining if the estimated averaged error and precision are acceptable;

and

(b): generating the full library when the estimated averaged error and precision are determined to be acceptable.

In regards to **Claim 13,** Balasubramanian et al. disclose:

(a): a test is performed to see if one or more data gathering criteria (average error and precision: see references and background material for Claim 12) are met: [0069]; lines 1-2 and Figure 3.

(b): if the data criteria are met then a library of simulated diffraction signals and associated profile data is created: [0062]; lines 1-5 and [0063]; lines 2-5. The size of the library, full or mini, is inherently dependent on a broad category template [0110]; line 7 or a sub-template [0110]; line 11 respectively.

Claim 14: The method of claim 13, wherein determining if the estimated averaged error and precision are acceptable comprises: providing the estimated averaged error and precision to a user.

In regards to **Claim 14,** Balasubramanian et al. disclose:

The involvement of user(s) in the process of creating profile models and libraries: [0061]; lines 1-10 and [0099]; lines 10-14.

Claim 16: The method of claim 13, further comprising:

(a): processing test diffraction signals using the generated full library; and

(b): estimating an averaged error and precision for the full library based on results of processing the test diffraction signals.

In regards to **Claim 16**, Balasubramanian et al. disclose:

(a): a library of calculated (simulated) diffraction beam data (signals) representing varying combinations of critical dimensions of target structure and resolution of the critical dimensions. (The said library would inherently contain a broad range of data necessary to build a full library): [0044]: lines 12-15 and Figure 1. Profile models (hypothetical profiles) of varying complexities which are used to build the full library are disclosed in [0054]; lines 1-23. Sub-templates, which would inherently generate subsets (mini-libraries) from the full library are shown in [0110]; lines 1-18.

Application server process the measured diffraction signals and the library of calculated (simulated) diffraction signals: [0044]; lines 9-15.

(b): the library optimization process includes determining two parameters an average error and a precision based on measured

diffraction signals and simulated diffraction signals and their corresponding profiles respectively:

Average error: the average value of one parameter or set of parameters are used as a target (average error): [0085]; lines 1-14 and [0086]; lines 1-3.

Precision: (Precision is the second data criterion selected by the Applicants. Applicants' disclosure define an example of a precision criterion as the 3-times the standard deviation of a set of measured diffraction signals. (Note: the said precision criterion is commonly used in statistical quality control)).

Balasubramanian et al. also disclose a second data gathering criterion precision: the 3-sigma (standard deviation) of measured diffraction signals for the same site in the wafer: [0065]; lines 9-12.

Claim 17: The method of claim 13, further comprising:

Altering the average and/or resolution of one or more parameters that characterize the hypothetical profile when the estimated averaged error and precision are not acceptable.

In regards to **Claim 17,** Balasubramanian et al. disclose:

a profile model based on a template having one or more parameters including characteristics of process and modeling attributes associated with the structure of the wafer. The profile model includes a set of geometric parameters associated with the dimensions of the structure. The generated profile model may further be tested against termination criteria (optimization criteria) and one more parameters modified as shown in the Abstract and the following specific criteria:

Average error: the average value of one parameter or set of parameters are used as a target (average error): [0085]; lines 1-14 and [0086]; lines 1-3.

Precision: (Precision is the second data criterion selected by the Applicants. Applicants' disclosure define an example of a precision criterion as the 3-times the standard deviation of a set of measured diffraction signals. (<u>Note:</u> the said precision criterion is commonly used in statistical quality control)).

Balasubramanian et al. also disclose a second data-gathering criterion precision: the 3-sigma (standard deviation) of measured diffraction signals for the same site in the wafer: [0065]; lines 9-12.

In step 460 of Figure 3 a test is performed to see if one or more data

gathering criteria are met: [0069]; lines 1-2. This test will inherently include the average error and precision.

If the data gathering criteria are not met then additional characterization data is obtained or data gathering criteria are adjusted in step 470 and Figure 3: [0070]; lines 4-6.

Claim 18: The method of claim 1, further comprising:

determining a measurement die pattern based on the sample diffraction signals, wherein each location in the measurement die pattern corresponds to each location on the wafer from which the sample diffraction signals were obtained.

In regards to **Claim 18**, Balasubramanian et al. disclose:

Selecting representatives of each cluster or highly correlated measured diffraction signals are identified and selected off the wafer: [0067]; lines 16-19. This process will inherently identify a specific measurement die pattern off the wafer.

Claim 28: A system to select a hypothetical profile to model the profile of a structure formed on a semiconductor wafer to use in determining the profile of the structure using optical metrology, the system comprising:

(a): a photometric device configured to obtain measured diffraction signals from structures formed on the wafer; and

(b): a processing module configured to:

obtain sample diffraction signals from the measured diffraction signals, wherein the sample diffraction signals are a representative sampling of the measured diffraction signals;

and

(c): evaluate a hypothetical profile using a sample diffraction signal from the obtained sample diffraction signals.

In regards to **Claim 28**, Balasubramanian et al. disclose:

(a): Figure 1 shows a photometric device to measure diffraction signals off structures patterned on a wafer: [0044]; lines 1-9.

(b): The measured diffraction signals are transmitted to a profile application server 53: [0044]; lines 9-10 and Figure 1. In Figure 3 and step 440, a selection of representative diffraction signals take place: [0067]; lines 6-12.

(c): [0067]; lines 16-19. Figure 3 describes the steps of selecting, evaluating the structure model (hypothetical profile).

Claim 30: The system of claim 28, wherein the processing module is

configured to evaluate the hypothetical profile by:

(a): accessing a sample diffraction signal from the obtained sample diffraction signals;

(b):. determining a simulated diffraction signal corresponding to the sample diffraction signal;

(c): determining a goodness of fit between the sample diffraction signal and the simulated diffraction signal; and

(d): modifying the hypothetical profile when the goodness of fit does not meet a goodness of fit criterion.

In regards to **Claim 30,** Balasubramanian et al. disclose:

(a): obtain measured diffraction signals off several sites in the wafer: [0096]; lines 7-9 and the input data may be transmitted to a template selector: [0096]; lines 9-13 and Figure 20.

(b): for each measured signal perform the procedure to determine the corresponding optimized simulated signal: [0098]; lines 1-4 and Figure 7.

(c): the Goodness Of Fit (GOF) is used as the termination criterion in the process of matching the measured signal to a simulated signal: [0069]; lines 1-5 and step 460 in Figure 3.

(d): continuing with step 470 in Figure 3, if the termination criterion (data

selection criterion) is not met then the profile model (hypothetical profile) is adjusted accordingly: [0070]; lines 4-6.

Claim 31: The system of claim 28, wherein the processing module is configured to evaluate the hypothetical profile by:

(a): accessing a sample diffraction signal from the obtained sample diffraction signals;

(b): determining a simulated diffraction signal corresponding to the sample diffraction signal;

(c): determining a global minimum error; and

(d): modifying the hypothetical profile when the global minimum error exceeds a global minimum error criterion.

In regards to **Claim 31**, Balasubramanian et al. disclose:

A profile application server 53 in Figure 1 process the measured diffraction signals against a library 54 of calculated diffraction signals: [0044]; lines 9-13.

(a): obtaining measured diffraction signals from several sites off the wafer and using a template to make a selection from the said diffraction signals: [0096]; lines 7-13.

(b): for each measured signal perform the procedure to determine the corresponding optimized simulated signal: [0098]; lines 1-4 and Figure 7.

(c): various optimization engines are used to arrive at a global minimum error (difference) between simulated signal and the measured signal: [0095]; lines 1-15 and Figure 7.

(d): If the termination criterion (error) is not met then the profile model (hypothetical profile) is adjusted as part of the process to minimize the error: [0098]; lines 11-18.

Claim 32: The system of claim 28, wherein the processing module is further configured to determine sensitivity for one or more parameters that characterize the hypothetical profile.

In regards to **Claim 32**, Balasubramanian et al. disclose:

A profile application server 53 in Figure 1, process the measured diffraction signals against a library 54 of calculated diffraction signals: [0044]; lines 9-15.

The sensitivity of the parameters associated with the profile model (hypothetical profile) is determined: [0090]; lines 1-14 and step 840 in Figure 5.

Claim 33: The system of claim 28, wherein the processing module is further configured to:

(a): generate one or more mini-libraries based on the obtained sample diffraction signals, wherein a mini-library is smaller in size than a full library to be generated;

(b): process test diffraction signals using the one or more mini-libraries; and

(c): estimating an averaged error and precision based on results of processing the test diffraction signals.

In regards to **Claim 33**, Balasubramanian et al. disclose:

A profile application server 53 in Figure 1 process the measured diffraction signals against a library 54 of calculated diffraction signals: [0044]; lines 9-13.

(a): a library of calculated (simulated) diffraction beam data (signals) representing varying combinations of critical dimensions of target structure and resolution of the critical dimensions. (The said library would inherently contain a broad range of data necessary to build a full library):

[0044]; lines 10-15 and Figure 1. Profile models (hypothetical profiles) of varying complexities which are used to build the full library are disclosed in

[0054]; lines 1-23. Sub-templates, which would inherently generate subsets (mini-libraries) from the full library are disclosed in [0110]; lines 1-18.

(b): process simulated (test) diffraction signals from one or more sub-templates (mini-libraries): [0110]; lines 11-18.

(c): the library optimization process includes determining two parameters an average error and a precision based on measured diffraction signals and simulated diffraction signals and their corresponding profiles respectively:

Average error: the average value of one parameter or set of parameters are used as a target (average error): [0085]; lines 1-14 and [0086]; lines 1-3.

Precision: (Precision is the second data criterion selected by the Applicants. Applicants' disclosure define an example of a precision criterion as the 3-times the standard deviation of a set of measured diffraction signals. (Note: the said precision criterion is commonly used in statistical quality control)).

Balasubramanian et al. also disclose a second data gathering criterion precision: the 3-sigma (standard deviation) of measured diffraction signals for the same site in the wafer: [0065]; lines 9-12.

Claim 34: The system of claim 33, wherein the processing module is further configured to:

(a): generate a full library when the estimated averaged error and precision are acceptable;

(b): alter the range and/or resolution of one or more parameters that characterize the hypothetical profile when the estimated averaged error and precision are not acceptable.

In regards to **Claim 34**, Balasubramanian et al. disclose:

(a): if the data criteria are met then a library of simulated diffraction signals and associated profile data is created: [0062]; lines 1-5 and [0063]; lines 2-5. The size of the library, full or mini, is inherently dependent on a broad category template [0110]; line 7 or a sub-template [0110]; line 11 respectively.

(b): a profile model based on a template having one or more parameters including characteristics of process and modeling attributes associated with the structure of the wafer. The profile model includes a set of geometric parameters associated with the dimensions of the structure. The generated profile model may further be tested against termination criteria (optimization criteria) and one more parameters modified as shown in the Abstract and

the following specific criteria:

Average error: the average value of one parameter or set of parameters are used as a target (average error): [0085]; lines 1-14 and [0086]; lines 1-3.

Precision: (Precision is the second data criterion selected by the Applicants. Applicants' disclosure define an example of a precision criterion as the 3-times the standard deviation of a set of measured diffraction signals. (<u>Note:</u> the said precision criterion is commonly used in statistical quality control)).

Balasubramanian et al. also disclose a second data-gathering criterion precision: the 3-sigma (standard deviation) of measured diffraction signals for the same site in the wafer: [0065]; lines 9-12.

In step 460 of Figure 3 a test is performed to see if one or more data gathering criteria are met: [0069]; lines 1-2. This test will inherently include the average error and precision.

If the data gathering criteria are not met then additional characterization data is obtained or data gathering criteria are adjusted in step 470 and Figure 3: [0070]; lines 4-6.

Claim 35: The system of claim 28, wherein the processing module is further configured to:

determine a measurement die pattern based on the sample diffraction signals, wherein each location in the measurement die pattern corresponds to each location on the wafer from which the sample diffraction signals were obtained.

In regards to **Claim 35**, Balasubramanian et al. disclose:

Selecting representatives of each cluster or highly correlated measured diffraction signals are identified and selected off the wafer: [0067]; lines 16-19. This process will inherently identify a specific measurement die pattern off the wafer.

Claim Rejections - 35 USC § 103

The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

> (a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negatived by the manner in which the invention was made.

Claim 2: The method of claim 1, wherein obtaining sample diffraction signals comprises:

(a): obtaining measured diffraction signals, wherein the measured diffraction signals are obtained from a plurality of locations on the wafer;

(b): determining a sample index, wherein the sample index corresponds to a number and a spacing of the sample diffraction signals;

(c): determining a cost distribution associated with the determined sample index; and

(d): adjusting the sample index when the determined cost distribution does not meet a cost criterion.

Claim 2 is rejected under 35 U.S.C. 103(a) as being unpatentable over Balasubramanian et al. (US 2004/0017575, FILING-DATE: 03/25/2003) in view of Doddi et al. (US 6,591,405 FILING-DATE: 11/28/2000).

In regards to **Claim 2**, Balasubramanian et al. teach:

(a): obtaining measured diffraction signals from several sites off the wafer and using a template to make a selection from the said diffraction signals: [0096]; lines 7-13.

(b): (Note: with Claim 2(b), applicants claim a sample index which is part of the first step of data mining technique based on clustering and/or

correlation).

More specifically, the applicants' sample index is based on clustering by partitioning which is a data mining technique where the sample diffraction signals are further arranged (partitioned) based on a number of diffraction signals and their spacing).

Balasubramanian et al. teach a data mining technique based on clustering and correlation: [0067]; lines 6-12 and Figure 3. Continuing, representatives of each cluster or group of highly correlated measured diffraction signals are identified and selected for use in the profile model (hypothetical profile) building process: [0067]; lines 16-19.

(Note: Clustering is inherently involving grouping data points (measured diffraction signals in our case) based on the number and spacing among them. The spacing is defined as the geometric distance in the multidimensional space, that is, the Euclidean distance. An optimization joining algorithm (grouping rule) is then used to group the data points together in a cluster based on a criterion set a priori).

In element **(b)** Balasubramanian et al. lack to define a sample index associated with number and spacing of the sample diffraction signals.

Doddi et al. teach a clustering method and optimization algorithm that uses an integer value K associated with the number of data points (measured diffraction values) which have been grouped in clusters and the spacing of the data points: column 9; lines 4-10 and column 10; lines 8-60.

Since both Balasubramanian et al. and Doddi et al. teach a selection/reduction technique based on clustering, it would have been obvious to one of ordinary skill in the art at the time the invention was made to have used the integer value K of Doddi et al. which is equivalent to the sample index of the Applicants, in Balasubramanian et al. with the motivation to be used in the optimization process of selecting the minimum number of measured diffraction signals that would be sufficient to build the library of the hypothetical profiles and their corresponding simulated diffraction signals with a target error (variably set) depending on specific requirements.

(c): Balasubramanian et al. further teach: the cost function as the data mining (selection) and the cost value associated with the cost function as the criterion to test whether sufficient data about the structure is available to perform the model and parameter selection in [0065]; lines 1-18 and the associated iterative process shown in Figure 3. Since the cost function is a density function, it (the density function) is inherently related to its distribution function.

(Note: The cost function is used to estimate the posterior probability density function of the unknown variables of a model. The cost function is the misfit (corresponding to an error) between the approximation and the actual posterior. The goal is to make the error zero (ideal case) but in practice, to lower the error to an acceptable value depending on the application the accuracy and the speed required for processing the data. The above acceptable value of the cost function is the applicants' cost criterion).

(d): Balasubramanian et al. further teach: the data gathering criterion (cost function value) may be adjusted if found to be set incorrect: [0070]; lines 1-18 and steps 470 and 480 in Figure 3.

Claim 3: The method of claim 2, wherein the cost criterion is a percentage

change in the cost distribution or a fixed quantity.

In regards to Claim 3, Balasubramanian et al. teach:

a value (cost criterion) for the cost function to be used as a data gathering criterion: [0065]; lines 4-5 and or a percentage change can be assigned to the cost criterion [0069]; lines 11-13.

Claim 15: The method of claim 13, wherein determining if the estimated averaged error and precision are acceptable comprises:

determining if the estimated averaged error and precision meet an error and precision criterion, wherein the precision criterion is approximately one order of magnitude less than the error associated with a photometric device to be used with the full library.

Claim 15 is rejected under 35 U.S.C. 103(a) as being unpatentable over Balasubramanian et al. (US 2004/0017575, FILING-DATE: 03/25/2003), in in view of Niu et al. (US 6,943,900, FILING-DATE: 07/16/2001, ISSUE-DATE: 09/13/2005)

In regards to **Claim 15,** Balasubramanian et al. teach both:

a library of calculated (simulated) diffraction beam data (signals) representing varying combinations of critical dimensions of target structure

and resolution of the critical dimensions. (The said library would inherently contain a broad range of data necessary to build a full library):

[0044]; lines 12-15 and Figure 1. Profile models (hypothetical profiles) of varying complexities which are used to build the full library are shown in [0054]; lines 1-23.

and

a test is performed to see if data gathering criteria are met: [0069]; lines 1-5 and Figure 3.

Balasubramanian et al. lack :

wherein the precision criterion is approximately one order of magnitude less than the error associated with a photometric device to be used with the full library.

Niu et al. et al. teach:

to use a resolution (precision) which is finer (higher) compared to the resolution (precision) of the instrumentation used to measure the diffraction signals as a guide in the process of selection of the target resolution (precision) for the library of profiles and their corresponding simulated diffraction signals: column 15: lines 30-65 and Figures 9 and 10.

Since both Balasubramanian et al. and Niu et al. et al. teach the option to

generate full libraries and selecting target library resolutions, it would have been obvious to one of ordinary skill in the art to modify Balasubramanian et al. application to use a target resolution better than the one of the measuring optical instrumentation, as taught by Niu et al. with the motivation to have a full range of hypothetical models and resolutions being generated once and then subsets of the same library to be used to run mini libraries as needed for specific manufacturing windows and precision and accuracy requirements in order to decrease the processing time as needed.

Claim 29: The system of claim 28, wherein the processing module is configured to obtain sample diffraction signals by:

(a): determining a sample index, wherein the sample index corresponds to a number and a spacing of the sample diffraction signals;

(b): determining a cost distribution associated with the determined sample index;

and

(c): adjusting the sample index when the determined cost distribution does not meet a cost criterion.

Claim 29 is rejected under 35 U.S.C. 103(a) as being unpatentable over Balasubramanian et al. (US 2004/0017575, FILING-DATE: 03/25/2003) in view of Doddi et al. (US 6,591,405 FILING-DATE: 11/28/2000).

In regards to **Claim 29**, Balasubramanian et al. teach:

(a): (Note: with Claim 29(a), applicants claim a sample index which is part of the first step of data mining technique based on clustering and/or correlation).

More specifically, the applicants' sample index is based on clustering by partitioning which is a data mining technique where the sample diffraction signals are further arranged (partitioned) based on a number of diffraction signals and their spacing).

Balasubramanian et al. teach a data mining technique based on clustering and correlation: [0067]; lines 6-12 and Figure 3. Continuing, representatives of each cluster or group of highly correlated measured diffraction signals are identified and selected for use in the profile model (hypothetical profile) building process: [0067]; lines 16-19.

(Note: Clustering is inherently involving grouping data points (measured diffraction signals in our case) based on the number and spacing among them. The spacing is defined as the geometric distance in the

multidimensional space, that is, the Euclidean distance. An optimization joining algorithm (grouping rule) is then used to group the data points together in a cluster based on a criterion set apriori).

In element **(a)** Balasubramanian et al. lack to define a sample index associated with number and spacing of the sample diffraction signals.

Doddi et al. teach a clustering method and optimization algorithm that uses an integer value K associated with the number of data points (measured diffraction values) which have been grouped in clusters and the spacing of the data points: column 9; lines 4-10 and column 10; lines 8-60.

Since both Balasubramanian et al. and Doddi et al. teach a selection/reduction technique based on clustering, it would have been obvious to one of ordinary skill in the art at the time the invention was made to have used the integer value K of Doddi et al. which is equivalent to the sample index of the Applicants, in Balasubramanian et al. with the motivation to be used in the optimization process of selecting the minimum number of measured diffraction signals that would be sufficient to build the library of the hypothetical profiles and their corresponding simulated diffraction signals with a target error (variably set) depending on specific requirements.

(b): Balasubramanian et al. further teach: the cost function as the data mining (selection) and the cost value associated with the cost function as the criterion to test whether sufficient data about the structure is available to perform the model and parameter selection in [0065]; lines 1-18 and the associated iterative process shown in Figure 3. Since the cost function is a density function, it (the density function) is inherently related to its distribution function.

(Note: The cost function is used to estimate the posterior probability density function of the unknown variables of a model. The cost function is the misfit (corresponding to an error) between the approximation and the actual posterior. The goal is to make the error zero (ideal case) but in practice, to lower the error to an acceptable value depending on the application the accuracy and the speed required for processing the data. The above acceptable value of the cost function is the applicants' cost criterion).

(c): the data gathering criterion (cost function value) may be adjusted if found to be set incorrect: [0070]; lines 1-18 and steps 470 and 480 in Figure 3.

Any inquiry concerning this communication or earlier communications from the examiner should be directed to Anastasios Tzathas whose telephone number is (571) 270-1617. The examiner can normally be reached on MON-TH, 7:30 to 5:00, alternate FRI, EST.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Steven Loke can be reached on (571) 272-1657. The fax phone number for the organization where this application or proceeding is assigned is 571-273-8300.

Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see http://pair-direct.uspto.gov. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free). If you would like assistance from a USPTO Customer Service Representative or access to the automated information system, call 800-786-9199 (IN USA OR CANADA) or 571-272-1000.

STEVEN LOKE
SUPERVISORY PATENT EXAMINER

Steven Loke

AT
3/30/07